

# Answers to Section Questions

## Section 1 • The Nature of Science

### Check for Understanding

- Page 2 Scientific theories are tested through experiments aimed to verify specific conclusions of the theories.
- Page 3 Scientific discovery involves continued testing and critical analysis for an idea before it is recognized as a theory. The people from various disciplines assist scientists in gathering and organizing information and improving ideas.
- Page 3 It is important to develop a research plan before fully investigating a problem because background information can be obtained that will assist in developing a hypothesis and devising an experimental design.
- Page 4 The statement of a hypothesis provides the scientist with a possible and testable explanation to a question. The experiment that follows will either support or refute the hypothesis.
- Page 5 The dependent variable in the ramp experiment is the time it takes to travel down the ramp.
- Page 6 Answers will vary, but may include graphs, tables, diagrams, charts, equations, matrices, and recorded observations.
- Page 7 Scientific research is an exacting process. Scientific discoveries must be fully scrutinized by the scientific community, including a review by peers as a means of checks and balances, before any research can be accepted as a theory.
- Page 12 Zeros that appear between significant digits and all final zeros of a number that appear to the right of the decimal are considered significant digits.
- Page 12 Precision is the degree of exactness of a measurement, but accuracy is the degree of agreement of a measurement with an accepted value.

### Caption Questions

- Page 5 Figure 1.3 Yes, assuming the balls are the same size and friction is the same in each trial.

### Quick Review

#### Pages 15–16

- Considerations should include the difference in the braking distance between new and old tires under several surface conditions, such as rain, ice, and dry road.
- Performing a large number of trials will help eliminate error, which in turn will lead to more accurate data.
- The third-party research organization could determine if the new tire significantly reduces braking distance by plotting a graph of how the new tires performed versus the performance of the old tire.
- Yes. The survival rate was greater for crashes in which safety belts were worn.
- Additional data that would better support this conclusion are the fatality and survival rates involving automotive accidents every year since safety belts were introduced.
- Using safety belts is a less risky behavior than not wearing safety belts because fewer people die when they use safety belts.
- 3
- 4
- 1
- 4
- Answers will vary but the units should be written in the form: "unit of length per page."
- 3

### Regents Exam Practice, pages 17–20

#### Part A

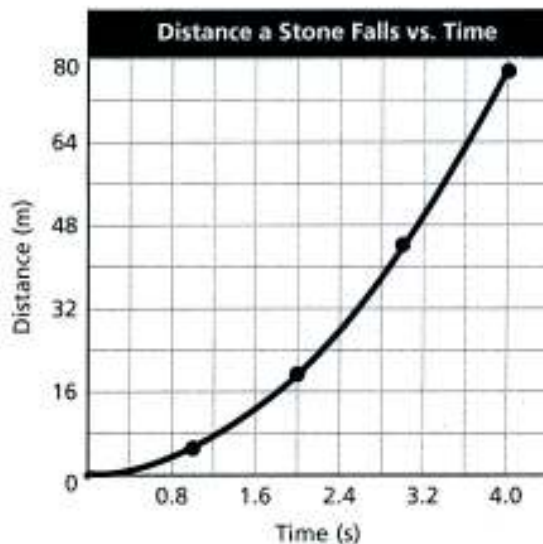
- (1) 4      (4) 2      (7) 4  
(2) 3      (5) 4      (8) 3  
(3) 3      (6) 3

#### Part B–1

- (9) 4      (10) 3      (11) 3

#### Part B–2

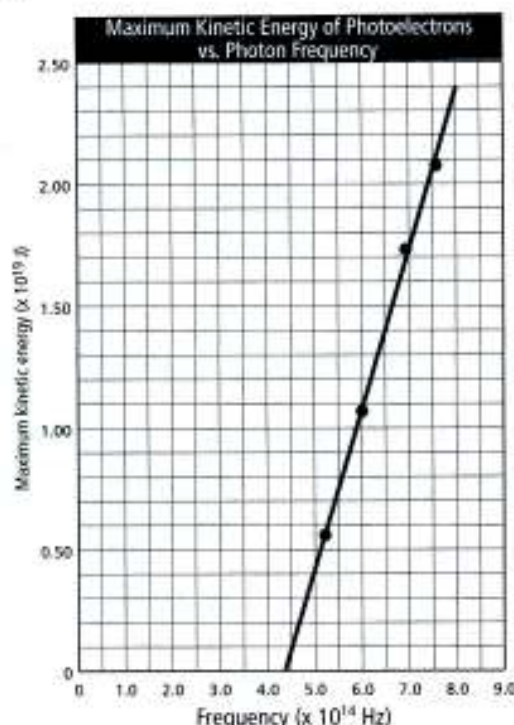
- (12) 4      (13) 2      (14) 3  
(15)



- (16) The best-fit line must be curved, as shown in the graph above. The relationship is quadratic.

Part C

(17)



All points must be plotted accurately ( $\pm 0.3$  grid space).

(18) The best-fit line must be straight, as shown in the graph above.

(19) Examples of acceptable responses:

These responses are based on the assumption that the best-fit line passes through the coordinates in the equation below.

$$\text{slope} = \frac{\Delta KE_{\text{max}}}{\Delta f}$$

$$\text{slope} = \frac{2.4 \times 10^{-19} \text{ J} - 0.4 \times 10^{-19} \text{ J}}{8.0 \times 10^{14} \text{ Hz} - 5.0 \times 10^{14} \text{ Hz}}$$

$$\text{slope} = 6.7 \times 10^{-34} \text{ J}\cdot\text{s}$$

or

$$\text{slope} = 0.67 \times 10^{-33} \text{ J/Hz}$$

## Section 2 • Mechanics

### Check for Understanding

Page 22 The change in position of a hockey puck as one team scores is a vector quantity.

Page 22 The resultant vector has a magnitude of 110 km and a direction of  $22^\circ$  east of north.

Page 23 vertical component:  $-3$   
horizontal component:  $0$

Page 24 Instantaneous speed is at a particular point in time and the average speed is the speed over a period of time.

Page 26 average acceleration:  $2 \text{ m/s}^2$

average speed:  $20 \text{ m/s}$

Page 27  $0.5 \text{ m/s}$

Page 29  $-9.81 \text{ m/s}^2$

Page 29  $0 \text{ m/s}^2$

Page 32  $0 \text{ N}$

Page 34  $3 \text{ N}$

Page 36 One must overcome static friction to start an object moving and static friction is greater than kinetic friction.

Page 38 The second spring will be easier to stretch.

Page 40 The momentum will increase.

### Caption Questions

Page 22 Figure 2.2  $102 \text{ km } 11^\circ$  west of north

### Quick Review

#### Page 25

(1) 3

(2) instantaneous speed

(3) 4

(4) 3

(5) 5 m

(6) 1

(7)  $4.0 \times 10^7 \text{ m/s}^2$

(8) 2

(9)  $90 \text{ m/s}$

#### Pages 30-31

(10) 1

(11) 3

(12) 40. s; 1200 m

(13) 1

(14)  $-6.0 \text{ m/s}^2$ ; 510 m

(15) 3

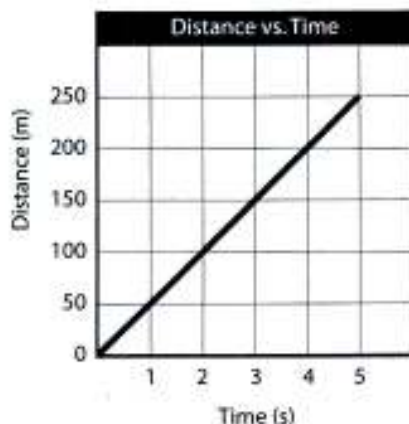
(16)

$t$ (s)	$d$ (m)	$v$ (m/s)	$a$ (m/s <sup>2</sup> )
0.0	0	0	20.
1.0	10.	20.	20.
2.0	40.	40.	20.
3.0	90.	60.	20.
4.0	160	80.	20.
5.0	250	$1.0 \times 10^2$	20.
6.0	360	120	20.



(17)

$t$ (s)	$d$ (m)
0.0	0.0
1.0	50
2.0	$1.0 \times 10^2$
3.0	150
4.0	200
5.0	250



The slope is the same as the speed:

$$m = \frac{\Delta y}{\Delta x} = \frac{250 \text{ m} - 0 \text{ m}}{5.0 \text{ s} - 0 \text{ s}} = \frac{250 \text{ m}}{5.0 \text{ s}}$$

$$= 50. \text{ m/s}$$

(18) 0 m/s;  $9.81 \text{ m/s}^2$  down

(19) a 20 km

b 14 km at  $45^\circ$  north of east

(20) 2

(21) 4

(22) 20.0 s; 491 m

(23) 78 m/s; 310 m

(24) 2

(25) 55 m/s

(26) 25 m/s

(27) 78 km at an angle of  $43^\circ$  east of north

(28) 2

(29) 63 m

(30) 60. m

(31) a 33 s; 3900 m

b Student diagrams should show an initial velocity vector at  $53^\circ$  to the horizontal. The parabolic path should be like Figure 2.9, drawn with velocity vectors tangent to the path.

**Page 39**

(32) 2

(34) 2

(36) 3

(33) 1

(35) 4

(37) Angle =  $0^\circ$ ;

$$F_{\text{net}} = 10. \text{ N} + 10. \text{ N} = 20. \text{ N}$$

Angle =  $90^\circ$ ;

$$F_{\text{net}}^2 = (10. \text{ N})^2 + (10. \text{ N})^2$$

$$F_{\text{net}} = \sqrt{2.0 \times 10^2 \text{ N}} = 14 \text{ N}$$

Angle =  $180^\circ$ ;

$$F_{\text{net}} = 10. \text{ N} - 10. \text{ N} = 0 \text{ N}$$

Angle =  $0^\circ$ ;

$$F_{\text{net}} = 70. \text{ N} + 40. \text{ N} = 110. \text{ N}$$

Angle =  $90^\circ$ ;

$$F_{\text{net}}^2 = (70. \text{ N})^2 + (40. \text{ N})^2$$

$$F_{\text{net}} = \sqrt{6500 \text{ N}} = 81 \text{ N}$$

Angle =  $180^\circ$ ;

$$F_{\text{net}} = 70. \text{ N} - 40. \text{ N} = 30. \text{ N}$$

(38) 98.1 N; 39.2 N; 0.41 kg; 1.02 kg

(39) a  $F_{\text{normal}}$ : -203 N;  $F_{\text{parallel}}$ : 457 Nb For a  $30^\circ$  incline:  $F_{\text{normal}}$ : -433 N;  $F_{\text{parallel}}$ : 250 N

c As the angle of the incline decreases, the normal force increases and the parallel force decreases.

(40) The centripetal force points toward the center of the circle because a force in this direction maintains circular motion.

(41)  $T = 0.2 \text{ s}$ ;  $f = 10 \text{ rev/s}$ 

(42) 1

(43) centripetal acceleration:  $62 \text{ m/s}^2$ ; tension: 120 N

(44) Weight depends on gravity and gravity varies depending on how high above Earth the object is.

(45) weight = 98.1 N; mass = 10.0 kg; weight = 16.4 N

(46)  $8.0 \times 10^{-8} \text{ N}$ 

(47) an experiment comparing the acceleration of a baseball and bowling ball being thrown with the same force

(48) 2

(49) 2

(50) 2

(51) 20 N

(52) Ignoring air resistance, the net force on the skydiver and acceleration remain the same because of Newton's second law.

**Page 41**(53)  $J = 2.0 \times 10^2 \text{ N}\cdot\text{s}$ 

$$\Delta v = 1.0 \times 10^2 \text{ m/s}$$

(54)  $m = 1.0 \times 10^3 \text{ kg}$ 

$$\Delta p = 25,000 \text{ kg}\cdot\text{m/s}$$

$$t = 25 \text{ s}$$

(55)  $m = 799 \text{ kg}$   
 $\Delta p = 2.00 \times 10^4 \text{ kg}\cdot\text{m/s}$   
 $t = 200. \text{ s}$

(56) a.  $\Delta p = 60. \text{ N}\cdot\text{s}$   
 b.  $\Delta v = 20. \text{ m/s}$

(57)  $v_{f2} = 11.5 \text{ m/s}$   
 $\Delta p_1 = 40.0 \text{ kg}\cdot\text{m/s}$   
 $\Delta p_2 = 40.0 \text{ kg}\cdot\text{m/s}$

(58)  $1200 \text{ N}$

(59) 1 (60) 3

(61) Examples of acceptable responses include:

Momentum conserved?	Diagram at $t_1$	Diagram at $t_2$
Yes		
No		
Yes		
Yes		
Yes		
Yes		

(62) 4

### Regents Exam Practice, pages 42–48

#### Part A

- (1) 2 (5) 2 (9) 3 (13) 1  
 (2) 3 (6) 3 (10) 1 (14) 3  
 (3) 1 (7) 2 (11) 1  
 (4) 4 (8) 2 (12) 2

#### Part B–1

- (15) 2 (17) 3 (19) 4 (21) 1  
 (16) 3 (18) 4 (20) 4 (22) 2

#### Part B–2

(23) 1

(24) Sketches should include:

- Three arrows, each originating at point C and having the correct orientation: weight perpendicular to the horizontal, friction parallel to the incline, and normal force perpendicular to the incline.
- Arrowheads in the correct direction: weight directed down, friction directed up the incline, and normal force directed away from the incline.
- Labels: weight or  $F_g$ , friction or  $F_f$ , and normal force or  $F_N$ .

(25)  $F_g = mg = (10.0 \text{ kg})(9.81 \text{ m/s}^2) = 98.1 \text{ N}$

(26) Examples of acceptable responses include:

The block would accelerate.

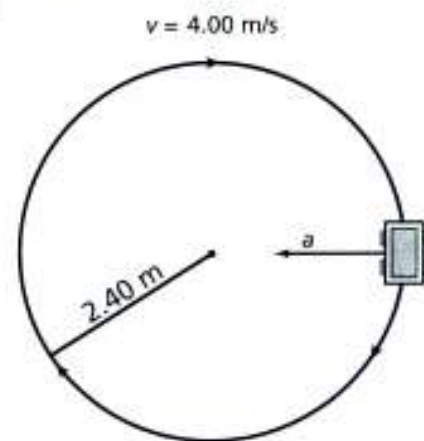
The speed of the block would not be constant.

The speed of the block would increase.

(27)  $t = \frac{2\pi r}{v}$   
 $= \frac{2(3.14)(2.40 \text{ m})}{(4.00 \text{ m/s})}$   
 $= 3.77 \text{ s}$

(28) doubling the speed

(29)



#### Part C

(30) scale:  $40. \text{ N}/6.6 \text{ cm} = 6.1 \text{ N/cm}$

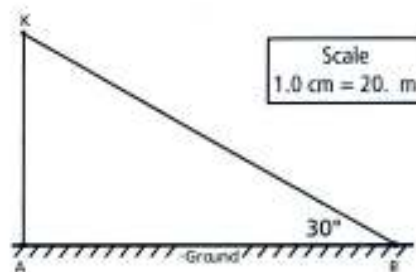
(31) Students should draw a vector that is about 7.4 cm long at an angle of  $27^\circ$  to the horizontal.

(32)  $F_{\text{net}} = \sqrt{(20. \text{ N})^2 + (40. \text{ N})^2} = 45 \text{ N}$

(33)  $27^\circ$  north of east

(34)  $a = F_{\text{net}}/m = 45 \text{ N}/10. \text{ kg} = 4.5 \text{ m/s}^2$

(35) Students should draw a right triangle with  $AB = 5.0 \text{ cm} (\pm 0.2 \text{ cm})$  and a  $30.^\circ (\pm 2^\circ)$  angle at point B. Points A and K should be labeled correctly.



Example of acceptable response:

(36)  $58 \text{ m} (\pm 2 \text{ m})$

(37) Example of acceptable response:

$$d = v_i t + \frac{1}{2} a t^2 \text{ or } d = \frac{1}{2} a t^2$$

$$t = \sqrt{\frac{2d}{a}}$$

$$t = \sqrt{\frac{2(58 \text{ m})}{9.81 \text{ m/s}^2}}$$

$$t = 3.4 \text{ s}$$

(38)  $30.^\circ \pm 2^\circ$

(39)  $140 \text{ m} \pm 20 \text{ m}$

(40)  $240 \text{ m}$  or  $140 \text{ m} + 100 \text{ m}$

(41) Example of acceptable responses:

$$\Delta d = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$\Delta d = \frac{1}{2} a (\Delta t)^2$$

$$\Delta t = \sqrt{\frac{2\Delta s}{a}}$$

$$\Delta t = \sqrt{\frac{2(240 \text{ m})}{9.81 \text{ m/s}^2}}$$

$$\Delta t = 7.0 \text{ s}$$

or

$$d = \frac{1}{2} a t^2 \text{ (from rest)}$$

$$t = \sqrt{\frac{2d}{a}}$$

$$t = \sqrt{\frac{2(240 \text{ m})}{9.81 \text{ m/s}^2}}$$

$$t = 7 \text{ s}$$

## Section 3 • Energy

### Check for Understanding

Page 49 4 J

Page 50 The kinetic energy of a moving object is proportional to its mass.

Page 52  $P = W/t$  and  $W = Pt$ , which can have units of kilowatt-hours.

Page 55 In an ideal mechanical system, factors such as friction and air resistance are so small that they can be ignored.

Page 56 The two components of mechanical energy are kinetic energy and potential energy.

Page 57 nuclear energy

Page 59 The label refers to temperature on a Fahrenheit scale.

Page 61 Cooling the balloon causes a decrease in pressure and volume of gas in the balloon.

Page 63 As air escapes from the aerosol can, the decrease in pressure creates a decrease in internal energy. The decrease in internal energy causes the decrease in temperature.

Page 63 The friction between the tire and the road converts mechanical energy to thermal energy, which increases the pressure inside the tire.

Page 64 No; if work is done on a system, heat can flow from a cooler object to a hotter object; this occurs in a heat engine.

### Caption Questions

Page 50 Figure 3.2 No work has been done because the force is not in the same direction as the motion.

Page 61 Figure 3.10 The balloon will shrivel because the collision rate among gas particles in the balloon decreases as temperature decreases.

### Quick Review

#### Pages 52–53

(1) The car's kinetic energy is greater.

(2) 4 (6) 3 (10) 3

(3) 3 (7) 2 (11) 2

(4) 2 (8) 4 (12) 1

(5) 4 (9) 2

(13) a  $2.0 \times 10^2 \text{ N}$

b  $5.9 \times 10^4 \text{ J}$

c  $2.40 \times 10^5 \text{ J}$

d 130 W

(14) 2 (15) 3 (16) 4

#### Pages 54–55

(17) 1 (20) 2 (23) 0.101 J

(18) 3 (21) 41 J

(19) 3 (22) 3190 J

#### Page 57

(24) 1 (26) 1

(25) 1 (27) 3

#### Page 61

(28) 2

(29) The energy needed to vaporize 30.0 grams of water is greater because it takes almost seven times more energy per gram to vaporize water than it does to melt ice.

(30) 4



- (31) When objects are in thermal contact, energy is transferred in particle collisions. There is a net transfer of energy from hotter objects to colder objects because hotter objects have more particles with higher energies.

**Page 64**

- (32) 2      (33) 2      (34) 2

- (35) 1

- (36) Yes; the second law of thermodynamics is not violated because either work must be done on the system or thermal energy must leave the system. In either case, the total entropy of the universe increases.

- (37) 3

**Regents Exam Practice, pages 65–68**

**Part A**

- |       |       |        |        |
|-------|-------|--------|--------|
| (1) 2 | (5) 2 | (9) 1  | (13) 2 |
| (2) 1 | (6) 4 | (10) 4 | (14) 4 |
| (3) 1 | (7) 4 | (11) 3 | (15) 4 |
| (4) 4 | (8) 1 | (12) 1 | (16) 1 |

**Part B–1**

- (17) 4

- (18) 1      (19) 3      (20) 3

- (21)  $\Delta PE = mg(h_2 - h_1)$

- (22) 4

**Part B–2**

- (23) 1

- (24) Example of acceptable response:

$$KE = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2KE}{m}}$$

$$= \sqrt{\frac{2(32 \text{ J})}{4.0 \text{ kg}}}$$

$$= \sqrt{16 \frac{\text{m}^2}{\text{s}^2}}$$

$$v = 4.0 \text{ m/s or } v = 4.0 \sqrt{\frac{\text{J}}{\text{kg}}}$$

- (25) The speed of the mass at 6.0 s and the speed of the mass at 10.0 s are both 4.0 m/s.

**Part C**

- (26)  $W = Fd$

$$W = (680 \text{ N})(3.5 \text{ m})$$

$$W = 2.4 \times 10^3 \text{ N}\cdot\text{m}$$

or

$$W = 2400 \text{ J}$$

$$(27) P = \frac{W}{\Delta t}$$

$$P = \frac{(2400 \text{ J})}{(11.4 \text{ s})}$$

$$P = 2.1 \times 10^2 \text{ W}$$

or

$$P = \frac{W}{t}$$

$$P = \frac{(2380 \text{ J})}{(11.4 \text{ s})}$$

$$P = 210 \text{ J/s}$$

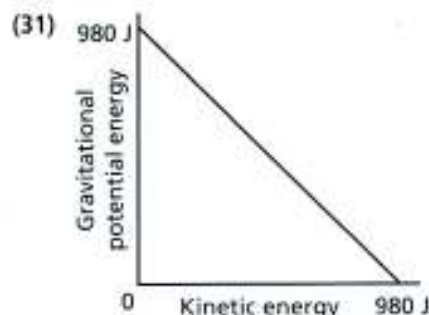
- (28) The power developed during the 11.4-second trial is less than the power developed during the 8.5-second trial.

- (29)  $\Delta PE = mg\Delta h$

$$\Delta PE = (20. \text{ kg})(9.81 \text{ m/s}^2)(5.0 \text{ m})$$

$$\Delta PE = 980 \text{ J or } 9.8 \times 10^2 \text{ kg}\cdot\text{m}^2/\text{s}^2$$

- (30) 980 J



## Section 4 • Electricity and Magnetism

### Check for Understanding

- Page 70 Conduction requires objects to come into contact with each other; induction requires close proximity but no contact.
- Page 71  $k$  is the electrostatic constant and its value is  $8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
- Page 74 An electric field is the modified space around a charge. Forces act on charged objects within the field.
- Page 75 Volts are the unit of measure for the electric potential difference.
- Page 75 One plate is positively charged; its complementary plate is negatively charged.
- Page 76 the force exerted by the electric field between the charged plates
- Page 78 An ampere is the SI unit for measuring the magnitude of current. It is defined as 1 coulomb per second.
- Page 79 an energy source (battery) and a wire